WHAT IS CLAIMED IS:

1. An in situ tumor temperature profile measuring probe, comprising:

an elongated rod including a pair of opposite end portions, an outer insulating layer having a plurality of spaced apart holes defined therein at one of said opposite end portions of said rod, and a common electrical input lead extending between said opposite end portions of said rod and disposed below said holes and having portions exposed at said holes, said common electrical input lead being adapted to provide an electrical input signal;

a plurality of spaced apart thermal sensors each formed within one of said holes of said outer insulating layer of said rod in electrical contact with said common electrical input lead of said rod, each of said thermal sensors being adapted to receive the electrical input signal from said common electrical input lead, to sense the temperature of biological matter adjacent to where said thermal sensor is placed and to produce an electrical output signal correlated to the temperature sensed; and

a plurality of electrical output leads each mounted to said outer insulating layer of said rod in electrical contact with a different one of said thermal sensors and extending to the other of said opposite end portions of said rod, each of said electrical output leads being adapted to receive the electrical output signal from said one of said thermal sensors and output the electrical output signal to means for collecting the output signals and forming a temperature profile of the biological matter.

2. The probe of claim 1 in which said common electrical input lead of said rod is a hollow tube made of an electrically conductive material.

3. The probe of claim 1 in which said common electrical input lead of said rod is an elongated strip made of an electrically conductive material.

4. The probe of claim 1 in which said holes and said thermal sensors therein are arranged in a linear array in which said thermal sensors are aligned axially with respect to one another along said rod.

5. The probe of claim 1 in which said holes and said thermal sensors therein are arranged in a staggered array in which said thermal sensors are offset circumferentially and axially with respect to one another about and along said rod.

6. The probe of claim 1 in which each of said thermal sensors and said electrical output leads is micron-scale in size.

7. The probe of claim 1 further comprising an exterior insulating layer covering at least said electrical output leads.

8. An in situ breast temperature profile measuring probe assembly, comprising:

a measuring probe including

a pair of opposite end portions, an outer insulating layer having a plurality of spaced apart holes defined therein at one of said opposite end portions of said rod, and a common electrical input lead extending between said opposite end portions of said rod and disposed below said holes and having portions exposed at said holes, said common electrical input lead being adapted to provide an electrical input signal,

a plurality of spaced apart thermal sensors each formed within one of said holes of and on said outer insulating layer of said rod in electrical contact with said common electrical input lead of said rod, each of said thermal sensor being adapted to receive the electrical input signal from said common electrical input lead, to sense the temperature of biological matter adjacent to where said thermal sensor is placed and to produce an electrical output signal correlated to the temperature sensed, and

a plurality of electrical output leads each mounted to said outer insulating layer of said rod in electrical contact with a different one of said thermal sensors and extending to the other of said opposite end portions of said rod, each of said electrical output leads being adapted to receive the electrical output signal from said one of said thermal sensors and output the electrical output signal to means for collecting the output signals and forming a temperature profile of the biological matter;

a hollow needle insertable into biological matter and having opposite ends and an interior passageway defined through said hollow needle which is open at each of said opposite ends thereof so as to adapt said hollow needle to receive said measuring probe through said interior passageway and guide said one end portion of said rod of said measuring probe into the biological matter; and

an electrical connector for providing an interface between said electrical output leads of said measuring probe and a computer, said electrical connector being adapted to receive said electrical output signals from said electrical output leads of said measuring probe and transmit the temperatures sensed by said thermal sensors of said measuring probe to the computer for collecting said output signals and forming a temperature profile of the biological matter.

9. The assembly of claim 8 in which said common electrical input lead of said rod of said measuring probe is a hollow tube made of a first electrically conductive material.

10. The assembly of claim 8 in which said common electrical input lead of said rod of said measuring probe is an elongated strip made of a first electrically conductive material.

11. The assembly of claim 8 in which said holes and said thermal sensors of said measuring probe are arranged in a linear array in which said thermal sensors are aligned axially with respect to one another along said rod.

12. The assembly of claim 8 in which said holes and said thermal sensors of said measuring probe are arranged in a staggered array in which said thermal sensors are offset circumferentially and axially with respect to one another about and along said rod.

13. The assembly of claim 8 in which each of said thermal sensors and said electrical output leads of said measuring probe is micron-scale in size.

14. The assembly of claim 8 in which said measuring probe also includes an exterior insulating layer covering at least said electrical output leads.

15. The assembly of claim 8 in which said hollow needle is removable from said measuring probe upon insertion of said measuring probe into the biological matter.

16. A method of measuring an in situ tumor temperature profile, said method comprising the steps of:

providing a common electrical input signal;

receiving the common electrical input signal at spaced apart locations within biological matter;

sensing temperatures of the biological matter at the spaced apart locations within the biological matter;

producing a plurality of electrical output signals corresponding to the respective temperatures sensed; and

transmitting the electrical output signals produced to a computer for collecting data.

17. The method of claim 16 further comprising the step of:
forming a temperature profile of the biological matter.

18. The method of claim 17 further comprising the step of:

using the temperature profile of the biological matter to determine whether a tumor is present and what type of a tumor may exist in the biological matter.

19. A method of measuring an in situ tumor temperature profile, said method comprising the steps of:

inserting a hollow needle into biological matter;

providing a measuring probe having a plurality of thermal sensors adapted to receive a common electrical input signal, to sense the temperature of the biological matter adjacent to where the thermal sensors are placed and to produce a

plurality of electrical output signals corresponding to the respective temperatures sensed by the thermal sensors;

inserting the measuring probe through the hollow needle so as to guide the measuring probe into the biological matter; and

transmitting the electrical output signals produced by the thermal sensors of the measuring probe to a computer for collecting data.

20. The method of claim 19 in which the step of inserting the measuring probe includes removing the hollow needle from the measuring probe after the measuring probe is disposed within the biological matter.

21. The method of claim 19 further comprising the step of forming a temperature profile of the biological matter.

22. The method of claim 21 further comprising the step of:

using the temperature profile of the biological matter to determine whether a tumor is present and what type of a tumor may exist in the biological matter.

IN SITU TUMOR TEMPERATURE PROFILE MEASURING PROBE AND METHOD

ABSTRACT OF THE DISCLOSURE

An in situ breast tumor temperature profile measuring probe includes a rod, thermal sensors and electrical output leads. The thermal sensors are formed in spaced apart holes in an outer insulating layer of the rod and a common electrical input lead to provide an electrical input signal to the thermal sensors is disposed below and has portions exposed at the holes and electrically connected to the thermal sensors. The thermal sensors receive the electrical input signal from the common electrical input lead, sense the temperature of biological matter adjacent to the thermal sensors and produce an electrical output signal correlated thereto. Each electrical output lead mounted to the outer insulating layer is in electrical contact with a different one of the thermal sensors to receive the electrical output signal from the one thermal sensor and output the same.

WHAT IS CLAIMED IS:

1. An in situ breast temperature profile measuring probe (12), comprising:

an elongated rod (20) including a pair of opposite end portions (20a, 20b), an outer insulating layer (26) having a plurality of spaced apart holes (30) defined therein at one (20a) of said opposite end portions of said rod (20), and a common electrical input lead (28) extending between said opposite end portions (20a, 20b) of said rod (20) and disposed below said holes (30) and having portions (28a) exposed at said holes (30), said common electrical input lead (28) being adapted to provide an electrical input signal;

a plurality of spaced apart thermal sensors (22) each formed within one of said holes (30) of said outer insulating layer (26) of said rod (20) in electrical contact with said common electrical input lead (28) of said rod (20), each of said thermal sensors (22) being adapted to receive the electrical input signal from said common electrical input lead (28), to sense the temperature of biological matter adjacent to where said thermal sensor (22) is placed and to produce an electrical output signal correlated to the temperature sensed; and

a plurality of electrical output leads (24) each mounted to said outer insulating layer (26) of said rod (20) in electrical contact with a different one of said thermal sensors (22) and extending to the other (20b) of said opposite end portions of said rod (20), each of said electrical output leads (24) being adapted to receive the electrical output signal from said one of said thermal sensors (22) and output the electrical output signal to means for collecting the output signals and forming a temperature profile of the biological matter.

2. The probe (12) of claim 1 in which said common electrical input lead (28) of said rod (20) is a hollow tube (40) made of an electrically conductive material.

3. The probe (12) of claim 1 in which said common electrical input lead (28) of said rod (20) is an elongated strip made of an electrically conductive material.

4. The probe (12) of claim 1 in which said holes (30) and said thermal sensors (22) therein are arranged in a linear array in which said thermal sensors (22) are aligned axially with respect to one another along said rod (20).

5. The probe (12) of claim 1 in which said holes (30) and said thermal sensors (22) therein are arranged in a staggered array in which said thermal sensors (22) are offset circumferentially and axially with respect to one another about and along said rod (20).

6. The probe (12) of claim 1 in which each of said thermal sensors (22) and said electrical output leads (24) is micron-scale in size.

7. The probe (12) of claim 1 further comprising an exterior insulating layer (32) covering at least said electrical output leads (24).

8. An in situ tumor temperature profile measuring probe assembly (10), comprising:

a measuring probe (12) including

a pair of opposite end portions (20a, 20b), an outer insulating layer (26) having a plurality of spaced apart holes (30) defined therein at one (20a) of said opposite end portions of said rod (20), and a common electrical input lead (28)

extending between said opposite end portions (20a, 20b) of said rod (20) and disposed below said holes (30) and having portions (28a) exposed at said holes (30), said common electrical input lead (28) being adapted to provide an electrical input signal,

a plurality of spaced apart thermal sensors (22) each formed within one of said holes (30) of and on said outer insulating layer (26) of said rod (20) in electrical contact with said common electrical input lead (28) of said rod (20), each of said thermal sensors (22) being adapted to receive the electrical input signal from said common electrical input lead (28), to sense the temperature of biological matter adjacent to where said thermal sensor (22) is placed and to produce an electrical output signal correlated to the temperature sensed, and

a plurality of electrical output leads (24) each mounted to said outer insulating layer (26) of said rod (20) in electrical contact with a different one of said thermal sensors (22) and extending to the other (20b) of said opposite end portions of said rod (20), each of said electrical output leads (24) being adapted to receive the electrical output signal from said one of said thermal sensors (22) and output the electrical output signal to means for collecting the output signals and forming a temperature profile of the biological matter;

a hollow needle (14) insertable into biological matter and having opposite ends (14a, 14b) and an interior passageway (38) defined through said hollow needle (14) which is open at each of said opposite ends (14a, 14b) thereof so as to adapt said hollow needle (14) to receive said measuring probe (12) through said interior passageway (38) and guide said one end portion (20a) of said rod (20) of said measuring probe (12) into the biological matter; and

an electrical connector (16) for providing an interface between said electrical output leads (24) of said measuring probe (12) and a computer (18), said electrical connector (16) being adapted to receive said electrical output signals from said electrical output leads (24) of said measuring probe (12) and transmit the

temperatures sensed by said thermal sensors (22) of said measuring probe (12) to the computer (18) for collecting said output signals and forming a temperature profile of the biological matter.

9. The assembly (10) of claim 8 in which said common electrical input lead (28) of said rod (20) of said measuring probe (12) is a hollow tube (40) made of a first electrically conductive material.

10. The assembly (10) of claim 8 in which said common electrical input lead (28) of said rod (20) of said measuring probe (12) is an elongated strip made of a first electrically conductive material.

11. The assembly (10) of claim 8 in which said holes (30) and said thermal sensors (22) of said measuring probe (12) are arranged in a linear array in which said thermal sensors (22) are aligned axially with respect to one another along said rod (20).

12. The assembly (10) of claim 8 in which said holes (30) and said thermal sensors (22) of said measuring probe (12) are arranged in a staggered array in which said thermal sensors (22) are offset circumferentially and axially with respect to one another about and along said rod (20).

13. The assembly (10) of claim 8 in which each of said thermal sensors (22) and said electrical output leads (24) of said measuring probe (12) is micron-scale in size.

14. The assembly (10) of claim 8 in which said measuring probe (12) also includes an exterior insulating layer (32) covering at least said electrical output leads (24).

15. The assembly (10) of claim 8 in which said hollow needle (14) is removable from said measuring probe (12) upon insertion of said measuring probe (12) into the biological matter.

16. A method of measuring an in situ tumor temperature profile, said method comprising the steps of:

providing a common electrical input signal;

receiving the common electrical input signal at spaced apart locations within biological matter;

sensing temperatures of the biological matter at the spaced apart locations within the biological matter;

producing a plurality of electrical output signals corresponding to the respective temperatures sensed; and

transmitting the electrical output signals produced to a computer (18) for collecting data.

17. The method of claim 16 further comprising the step of:
forming a temperature profile of the biological matter.

18. The method of claim 17 further comprising the step of:

using the temperature profile of the biological matter to determine whether a tumor is present and what type of a tumor may exist in the biological matter.

19. A method of measuring an in situ tumor temperature profile, said method comprising the steps of:

inserting a hollow needle (14) into biological matter;

providing a measuring probe (12) having a plurality of thermal sensors (22) adapted to receive a common electrical input signal, to sense the temperature of the biological matter adjacent to where the thermal sensors (22) are placed and to produce a plurality of electrical output signals corresponding to the respective temperatures sensed by the thermal sensors (22);

inserting the measuring probe (12) through the hollow needle (14) so as to guide the measuring probe (12) into the biological matter; and

transmitting the electrical output signals produced by the thermal sensors (22) of the measuring probe (12) to a computer (18) for collecting data.

20. The method of claim 19 in which the step of inserting the measuring probe (12) includes removing the hollow needle (14) from the measuring probe (12) after the measuring probe (12) is disposed within the biological matter.

21. The method of claim 19 further comprising the step of forming a temperature profile of the biological matter.

22. The method of claim 21 further comprising the step of:

using the temperature profile of the biological matter to determine whether a tumor is present and what type of a tumor may exist in the biological matter.